Pediatric Anesthesia

M. DIGBY LEIGH, M.D.,* *Vancouver, Canada*

SUMMARY

Induction of anesthesia in infants and children presents many problems not present in procedures for adults. Anesthetists may better serve the patient by visiting with him on the eve of operation, not only to establish friendly relations to avoid rebellion, but to form a basis for decision as to what anesthetic agent to use and by what method it should be given. As the kind of operation and the difficulties to be expected with each are large factors in the choice of agent and technique, a number of operative situations are reviewed from this standpoint.

THE staffs of pediatric hospitals fit themselves into the child's world and on the whole the pediatric hospital lacks the solemn quiet atmosphere of the adult institution. One often sees brightly colored murals, children playing with toys, and hears a radio or phonograph. In addition, there is lively chatter between the children. Hospitals employ play therapists, occupational therapists, and school teachers, all of whom help to maintain the normal atmosphere of the child.

A further improvement has been the increased interest in the patient before and after anesthesia. No longer does the anesthetist appear in the operating room solely to give the anesthetic. It is customary in an organized department to have the anesthetist visit the patient the night before operation, have a friendly chat and gain the little patient's confidence. Children are intensely interested in stories of sport, and in the case of the young child, the subject of Santa Claus is a happy selection.

Over the years it has been learned that it is important to correct any fluid or nutritional imbalance. If the operation is elective, a good night's sleep prior to operation is beneficial to the patient. A barbiturate administered the night before accomplishes this purpose. If it is given orally, the bitterness should be concealed in a generous portion of corn syrup. Smaller children may be given a barbiturate suppository. Solid food, which might be vomited and aspirated, should be withheld for six hours prior to operation. Sweetened liquids can be given up to two or three hours preoperatively. In most instances, the patient who has had a bowel movement the day before operation does not require an enema. The exception, however, is the patient on whom rectal operation is to be done, with a possibility that feces would interfere with the operative procedure.

In regard to pre-anesthetic medication immediately before operation, some difference of opinion has arisen. Many anesthetists give no premedication to children under seven or eight years of age. Their aversion is due largely to the fear of dangerous depression of respiration. On the other hand, there is a rapidly growing group of those who believe that premedication in infants and children can give the same results as it does in adults. The advantages of the immediate preoperative premedication are decrease in fear and reduction in the amount of anesthetic agent required for anesthesia. This is attained with barbiturates or opiates. One of the belladonna group of drugs can be added to this, either atropine or scopolamine. Both atropine and scopolamine decrease secretions in the respiratory tract and help maintain the patency of the airway. Scopolamine also produces some amnesia of the operative procedure.

Since the anesthetist is aware of the type of operation, and is familiar with the patient's condition, he can make a decision the night before regarding the anesthetic agent and method to be used. It has been argued that there is perhaps one best technique for each case. The author feels that this is not strictly true—that there is usually a choice of three or four agents and methods, and that the breadth of choice depends upon the skill and the training of the anesthesiologist. Hitherto, open drop ether was thought to be sufficient and safe for most pediatric operations, such as tonsillectomies, herniorrhaphies, and appendectomies. It was found, however, that the open drop method was not suitable for intracranial, intrathoracic and intra-abdominal operations. Therefore it was found necessary to adapt to infants and children some of the improved anesthetic agents and methods used for adults. Consequently, we now have a wide variety of anesthetic agents employed. These include the inhalation agents —cyclopropane, ethyl chloride, ethylene, divinyl ether, ethyl oxide (ether), chloroform, and nitrous oxide; the local anesthetic agents—cocaine, metycaine, nupercaine, pontocaine, and procaine; the barbiturates—pentothal and evipal; the muscle relaxant—curare; the basal anesthetic agents—ether in oil, paraldehyde, and tribromethanol in amylene hydrate. Likewise, there is the same variety of anesthetic methods: open drop, semi-open, insufflation, and absorption (both to-and-fro and in circuit techniques). Moreover, today in inhalation technique the endotracheal tube is employed more frequently.

*Director of anesthesia, Vancouver General Hospital, Vancouver, Canada.

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Other methods, such as intravenous, rectal, topical, infiltration, field blocks and nerve blocks (cervical, brachial plexus, caudal, and even spinal) have found their way into the pediatric field. Almost all agents and methods that are employed for adult anesthesia have been used successfully in infants and children with almost comparable benefits to both patient and surgeon.

There are numerous operations on the respiratory tract in which the problem of anesthesia is complicated. For example, anesthesia for a tracheotomy may be difficult because of respiratory obstruction. However, much of this may be overcome if a small endotracheal tube is passed beyond the laryngotracheal obstruction and a patent airway established early and maintained. The insertion of the endotracheal tube usually relieves anoxia and passive congestion so that during the incision there is less bleeding. The method of administering the anesthetic can be any one of the usual inhalation techniques carried on through the endotracheal tube. After the completion of the opening in the trachea, the surgeon should infiltrate with a local anesthetic the skin around the tracheotomy incision. As the tracheotomy tube is inserted the endotracheal tube is withdrawn. Following this the administration of the anesthetic can be continued by insufflation through a rubber catheter inserted into the tracheotomy tube. The local analgesia, however, is usually sufficient to allow for the suturing of the skin.

Difficulties may arise during anesthesia for bronchoscopy. If the procedure is being carried out in infants for examination or aspiration, no general anesthetic agent is administered, but the infant is given high oxygen inhalations by bag and mask for three minutes prior to insertion of the bronchoscope. This will provide an adequate reserve of oxygen in the respiratory tract, circulating blood and other body tissues should laryngospasm or bronchospasm occur. Older children may be anesthetized in this way, after a thorough local anesthetization of the pharynx and larynx. The author usually gives nitrous oxide before and during the procedure.

Bronchoscopy for foreign body extraction is a different problem. It is true that the foreign body can be extracted under general anesthesia with ether; but ideal working conditions for the surgeon may be provided by giving a combination of nitrous oxide and oxygen, a small dose of intravenous pentothal sodium, and a comparatively large dose of curare sufficient to relax all the muscles and prevent any resistance. The accompanying respiratory depression or arrest would cause anoxia; but this can be avoided by delivering oxygen through the side-arm of the bronchoscope. If there are a few holes along the wall of the bronchoscope, then, even if it is inserted into one bronchus, gas can still flow into the other lung. The anesthetist may have to aid respiration by intermittent manual pressure on the upper part of the abdomen. If this is not sufficient he can put his thumb over the opening of the bronchoscope and inflate the lungs rhythmically. During this procedure the chest should be watched closely so that there is no overdistention of the lungs.

The choice of a safe and satisfactory method of anesthetizing infants and children for bronchograms is always a problem. There are two main difficulties: first, the maintenance of a patent airway; second, the limitation to non-explosive agents. In the last few years the anesthetist has become increasingly aware of the dangers of explosive agents in the radiological department. In older children, the usual premedication of morphine and scopolamine is given. On the patient's arrival in the operating room a large dose of morphine is given intravenously. The pharynx and larynx are sprayed with 10 per cent cocaine or 2 per cent pontocaine. If the child is uncooperative, this spraying can be done alternately with nitrous oxide and oxygen inhalations administered with a bag and mask. The radiopaque catheter can be passed down through the nostril and inserted between the vocal cords by direct vision through the laryngoscope. In infants the procedure is exactly the same except that the morphine is omitted and the anesthesia must be maintained throughout with nitrous oxide and oxygen with bag and mask; otherwise, satisfactory films cannot be obtained. It is wise to have on hand an endotracheal tube and laryngoscope in case the air passage becomes blocked with the radiopaque substance. If this occurs the clean endotracheal tube can be inserted quickly.

OPERATIONS IN THE THORAX

Operations in the thorax in most infants and children should be done with an endotracheal tube in place. This prevents respiratory obstruction, and, with the closed absorption technique, permits of easy control of pulmonary ventilation. The endotracheal tube facilitates aspiration of tracheobronchial secretions. In the smaller infants, completely closed endotracheal absorption technique is not satisfactory. If the absorption technique is used it must be carried on as a semi-open system. In other words, an excess of gases is supplied. If absorption in circuit is used, it is important to be sure that the system is efficient and that there is no rebreathing. Usually the system is connected with a Neff water manometer so that overdistention of the lungs cannot occur. This manometer is set at approximately 12 cm. of water pressure. If the anesthesiologist controls the breathing by rhythmic manual compression on the breathing bag, any excess pressure will be reduced by the escape of the gas through the open arm of the Neff manometer. This system provides uniform inflation of the lungs. (Uneven expansion of the lungs is disturbing to the surgeon.) These principles apply to practically all intrathoracic operations. It must be kept in mind that lobectomies and pneumonectomies in children are often done for bronchiectasis, and there is a great deal of secretion that must be aspirated frequently throughout the operation lest the patient drown. Postural drainage and bronchoscopic aspiration immediately before operation are seldom completely adequate.

In arterioplasty, including repair of patent ductus, coarctation of the aorta, and tetralogy of Fallot, usually one lung is collapsed and the other must be kept ventilated throughout the operation.

In tetralogy of Fallot, the problem of acute anoxia is always at hand. In these cases constant vigil of the heart is important. Should the heart beats become slow and feeble, the surgeon should permit the anesthetist to inflate the collapsed lung in order to improve the oxygenation. This should change the sluggish heart beats to more rapid, vigorous contractions.

In all intrathoracic operations, at the time of the closure of the chest, the anesthetist attempts to inflate the lungs by pressure on the breathing bag. Negative intrathoracic pressure should be applied in all cases before the patient leaves the operating room. Gentle transfer from the operating table is important. Oxygen therapy should be administered continuously from the end of the operation until it is no longer necessary.

There are several operations in the region of the upper part of the digestive tract which are beset with hazards. (The term "digestive tract," as here used is in accord with the "Standard Nomenclature of Disease and Operations" of the American Medical Association.) Deaths have been recorded from cleft lip and palate operations and from tonsillectomy and adenoidectomy. Deaths from tonsillectomy are far more common than is generally known. For example, in figures tabulated by Bishop from the United States Bureau of Census, there were 542 deaths during tonsillectomy and adenoidectomy in 6,250 deaths which occurred on the operating table over a period of ten years. A large number of these deaths probably were due to obstruction to respiration. The popular method of anesthetizing patients undergoing these operations was to commence with open drop ether technique followed by ether insufflation, either through a mouth hook or through a nasopharyngeal catheter. With this method it is important to keep the patient in the Trendelenburg position so that the blood will not run into the trachea and obstruct it. Likewise, the mouth gag must not be opened too widely, for this also blocks the air passage. It is because of this difficulty with the patency of the airway that for the past six or seven years the author has used the endotracheal method, preferably the orotracheal. If the endotracheal method is used, tubes of the proper size must be inserted; otherwise laryngitis may follow the extubation. In fact, in over 20,000 intubations in infants and children, two tracheotomies were necessary postoperatively. One was performed the day following a tonsillectomy, and in the other, the operation followed injury to the left recurrent laryngeal nerve during ligation of a patent ductus. It is presumed that the paralysis of the left vocal cord together with some subglottic edema produced enough obstruction to endanger the patient's life. Tracheotomy was done within an hour of the operation and the opening was closed 48 hours later.

Recently, the author reported a series of 500 operations for cleft lip and palate with only three deaths. These too were done with endotracheal anesthesia. The endotracheal technique provided improved operative conditions for the surgeon. It must be remembered that the technique is not for the occasional anesthetist but for the expert. In infants under two years of age blood was supplied throughout these operations.

In operations for closure of a tracheoesophageal fistula, a different problem presents itself. In the first place, the operation is done during the first few days of life when pain sensation is at a minimum. Cyclopropane and oxygen blown over the face of the infant through the bag and mask provides adequate anesthesia; but an endotracheal tube and laryngoscope should be kept on hand in case of the sudden appearance of severe laryngospasm. In operating upon infants two or three days old, a new feature appears. These infants often lose body heat, and the body temperature may drop to 94° or 95° F. unless it is kept higher artificially. This can be done by placing the infant upon a blanket-covered perforated metal frame which is placed over hot water bottles. Falling temperature is not a problem in older children, in whom the body heat tends to rise during anesthesia.

PYLOROMYOTOMY FOR PYLORIC STENOSIS

A comparatively common operation in a pediatric hospital is pyloromyotomy for pyloric stenosis. The infant is operated on at about three weeks of age. Careful preoperative preparation with intravenous fluids and blood is a matter of great importance. Many surgeons prefer anesthetization by local infiltration of the abdominal wall in the region of the incision. Others, feeling that local anesthesia interferes with healing of the wound, prefer open drop ether, although in patients anesthetized by that method the intestine often bobs up and down elusively. Cyclopropane blown over the face through a bag and mask can also be used but is difficult to control. A safe method for the expert and one which gives excellent operating conditions is a combination of intravenous pentothal and curare with nitrous oxide and oxygen inhalation. An endotracheal tube may be employed and is a definite asset if some assistance to respiration is required. But again, the latter is not a method to be employed except by those well versed in pediatric anesthesia.

There are several other abdominal operations, such as anastomosis of the intestine, reduction of a volvulus, intussusception, choledochoplasty, appendectomy, and splenectomy, for which the patient can be anesthetized with the same agents and methods as outlined for pyloromyotomy. In older children, over five or six years of age, spinal anesthesia may be employed. In fact, in one pediatric hospital, spinal anesthesia is used in 10 per cent of the cases. Spinal anesthesia is usually combined with intravenous pentothal or a very dilute concentration of nitrous oxide in oxygen administered by bag and mask. In children the surgeon should not expect

the same contracted ribbon-like intestine that is seen in adults under spinal anesthesia. Perhaps the anesthetist is more cautious with children and keeps the level of analgesia lower.

Most urogenital operations can be accomplished with any of the anesthetic agents and methods used for adults. Caudal blocks and low spinal anesthesia can be used more frequently for these operations. In some cases circumcision can be satisfactorily done with a regional block at the base of the penis.

When operations on the endocrine system, thyroidectomy, thymectomy and adrenalectomy, are necessary for older children, the problems of choice of agent, method, and endocrine management are similar to those for adults.

With the rapidly growing group of trained neurosurgeons, neurosurgical operations such as craniotomy, cranioplasty, removal of subdural hematomata, and meningocele are increasing in number. Light anesthesia is required in these cases but a patent airway is essential. The so-called Ayre's open endotracheal method or the open valvular endotracheal method gives reliable results. Nitrous oxide and oxygen with the occasional addition of a small amount of ether is adequate for a light level of anesthesia. Proper oxygenation and carbon dioxide elimination, so important in these operations to prevent brain swelling, can be maintained for long periods of time. With these methods smaller endotracheal tubes can be used, which will materially reduce laryngitis following these protracted operations. Slightly different agents and methods must be used for anesthesia during encephalography because of the spark hazard. Intravenous and rectal pentothal and rectal avertin have been employed successfully. If the encephalography is not done by an expert, the patient may die during the procedure after only brief distress. Usually there is a slight coughing spell with sudden pallor and the patient dies in spite of immediate artificial respiration. This is more apt to occur in infants under one year of age.

There are many kinds of eye and ear operations in infants and children. Several of these are done under anesthesia induced with rectal avertin and with insufflation of nitrous oxide and oxygen through the nipple of a Waters' oropharyngeal airway. However, to avoid interfering with the surgeon's access to the patient's head, the endotracheal technique seems preferable, and it also gives a better guarantee of the patency of the airway.

Following operation, most patients are taken to a postanesthetic recovery room where they are carefully watched by nurses trained for this duty.